Polymer Technologies, Inc.

Materials For Controlling Noise

DESIGNED TO CONTROL NOISE

- SELECT “QUIET” COMPONENTS
- ISOLATE VIBRATING COMPONENTS
- FULLY ENCLOSE SOURCES

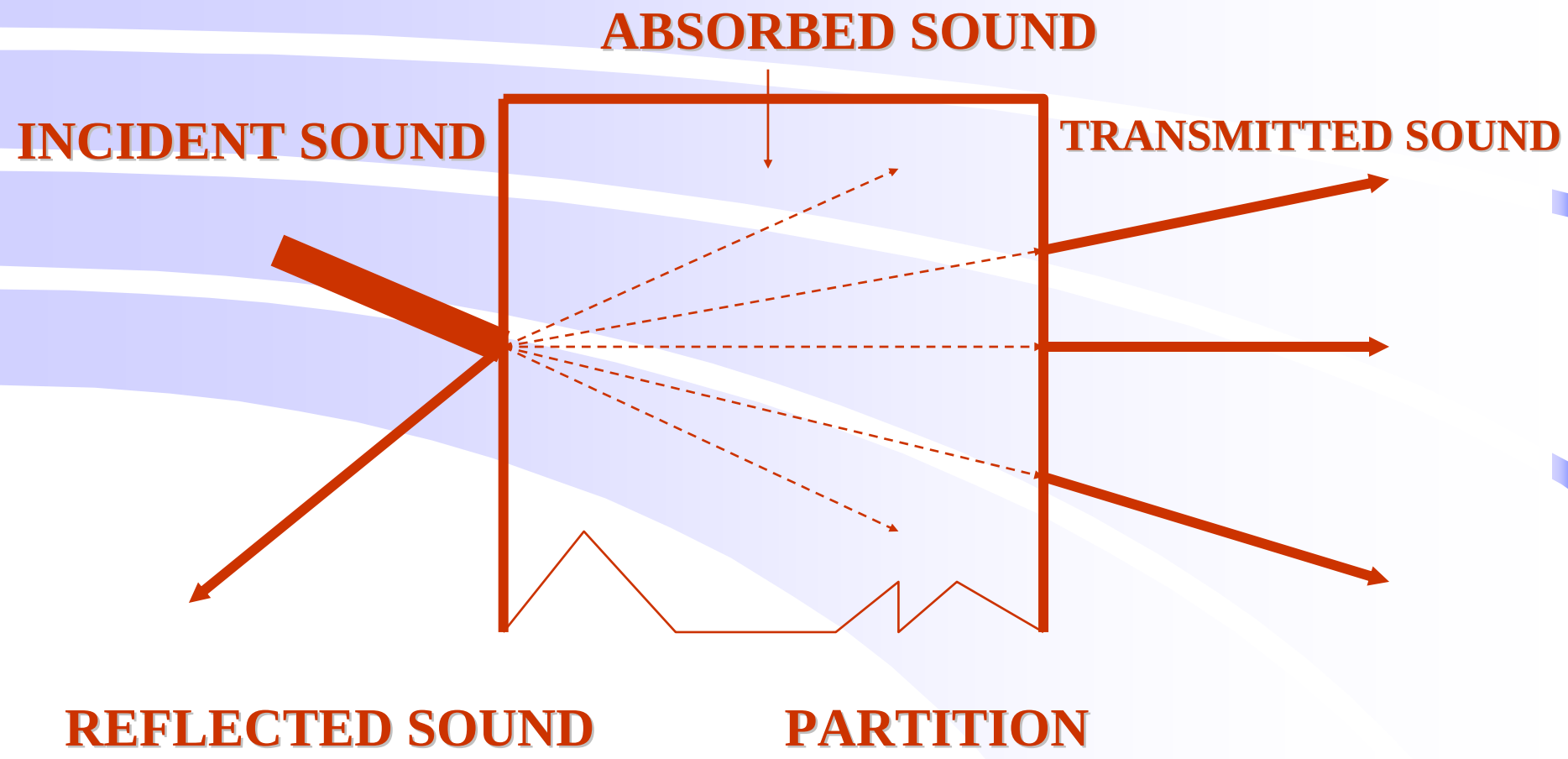
TRADITIONAL NOISE CONTROL MATERIAL SOLUTIONS

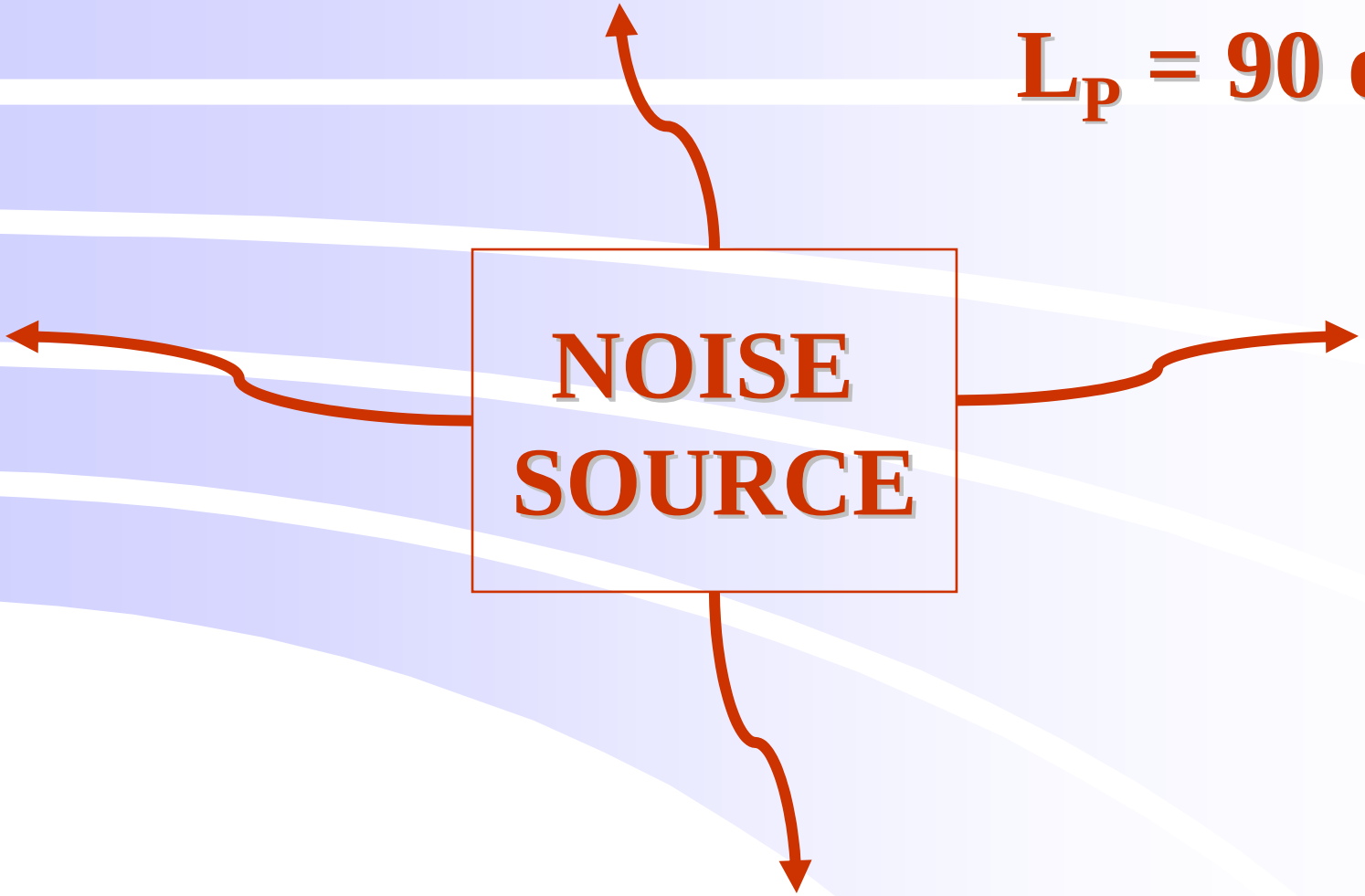
- **Absorption-** “Soak-up” airborne sound energy
- **Barriers-** Walls to stop sound energy
- **Damping-** Takes the “ring” out
- **Gasketing-** Seal between two surfaces
- **Isolation-** Decouples vibrators from structure

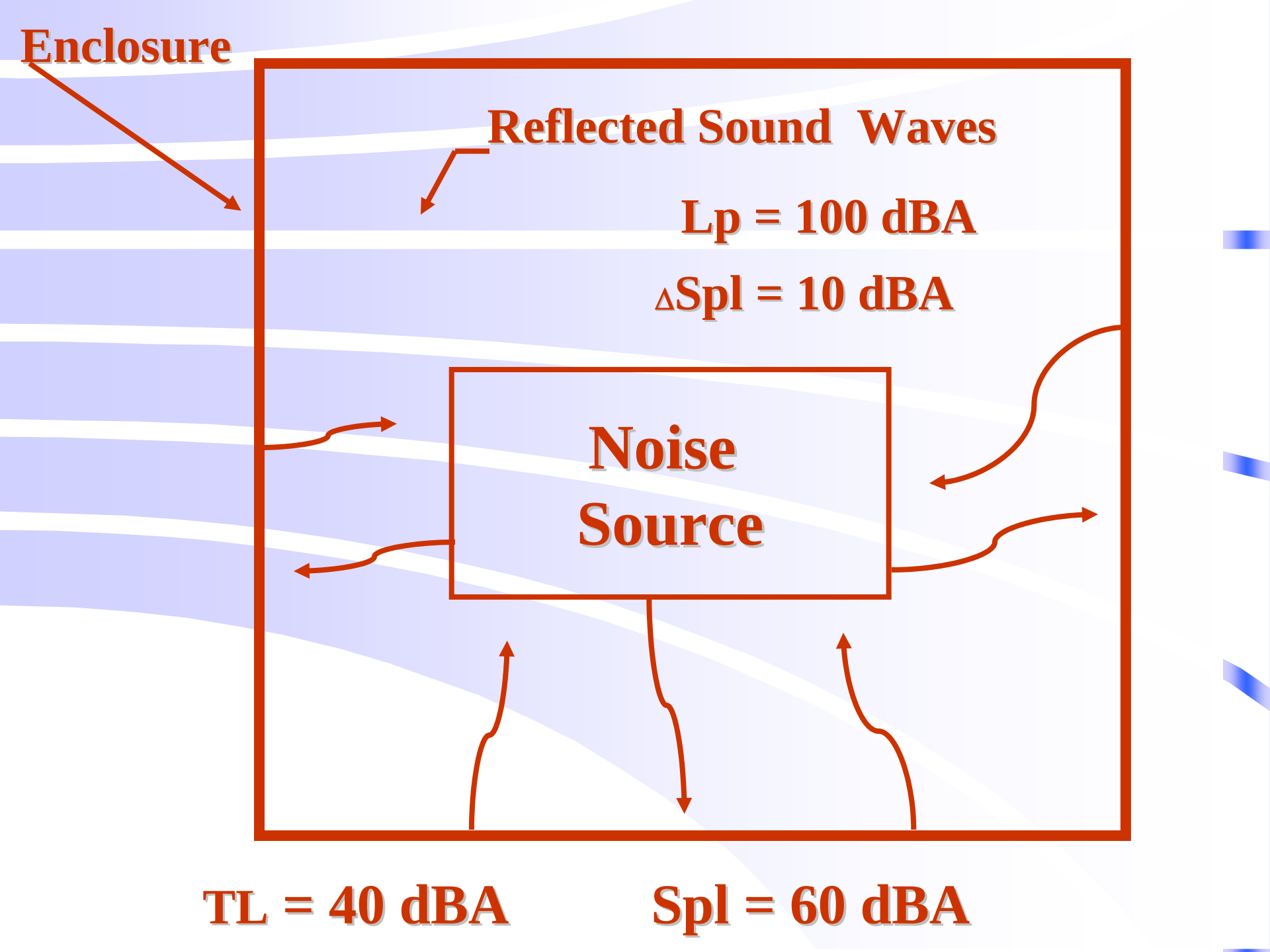
Relationship of Wavelength And Frequency

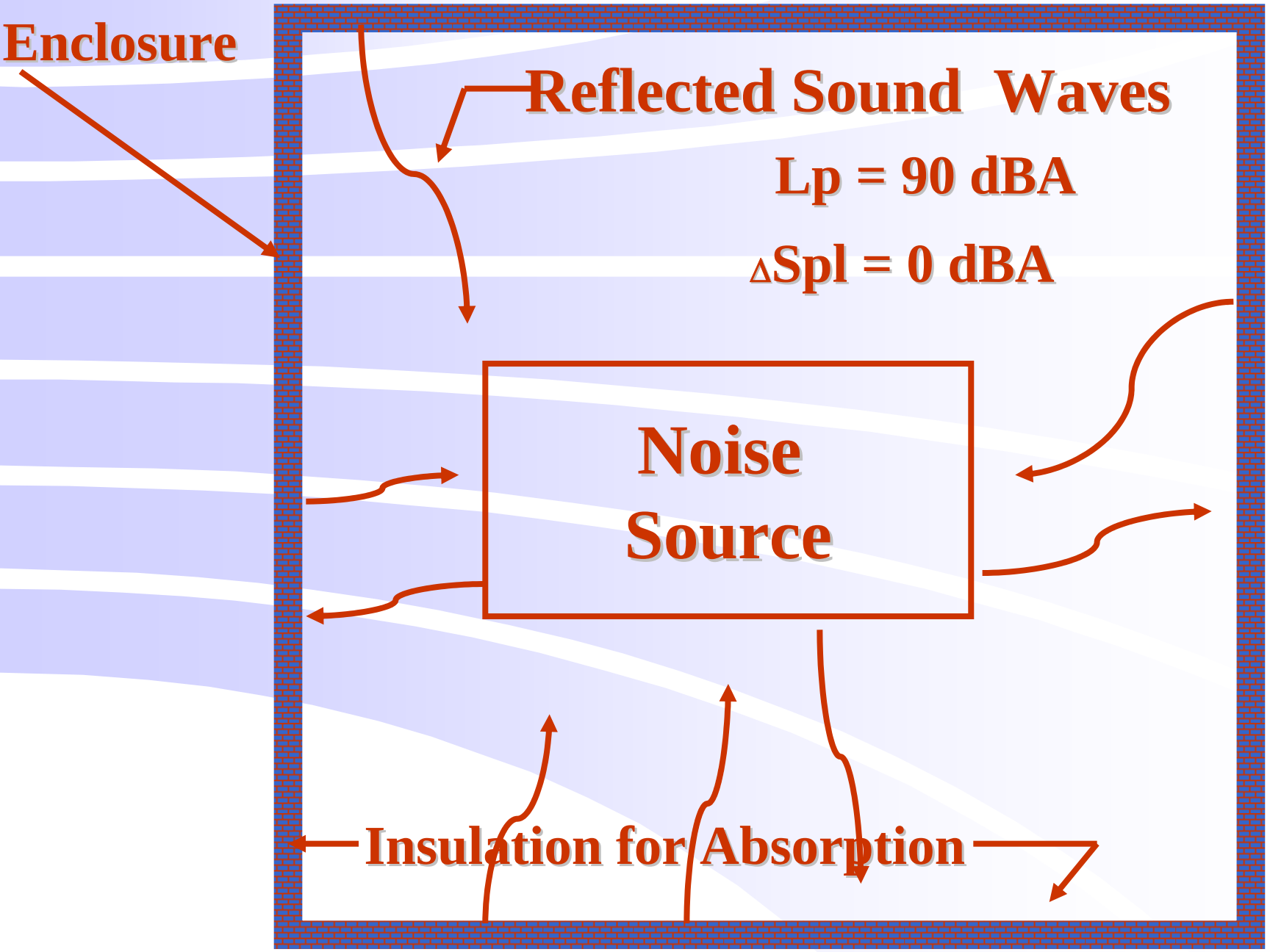
Frequency (Hertz)	Wavelength (ft or in)
16K	.85 IN
8 K	1.69 IN
4 K	3.38 IN
2 K	6.67 IN
1 K	1.13 FT
500	2.26 FT
250	4.51 FT
125	9.02 FT
60	18.8 FT
30	37.6 FT

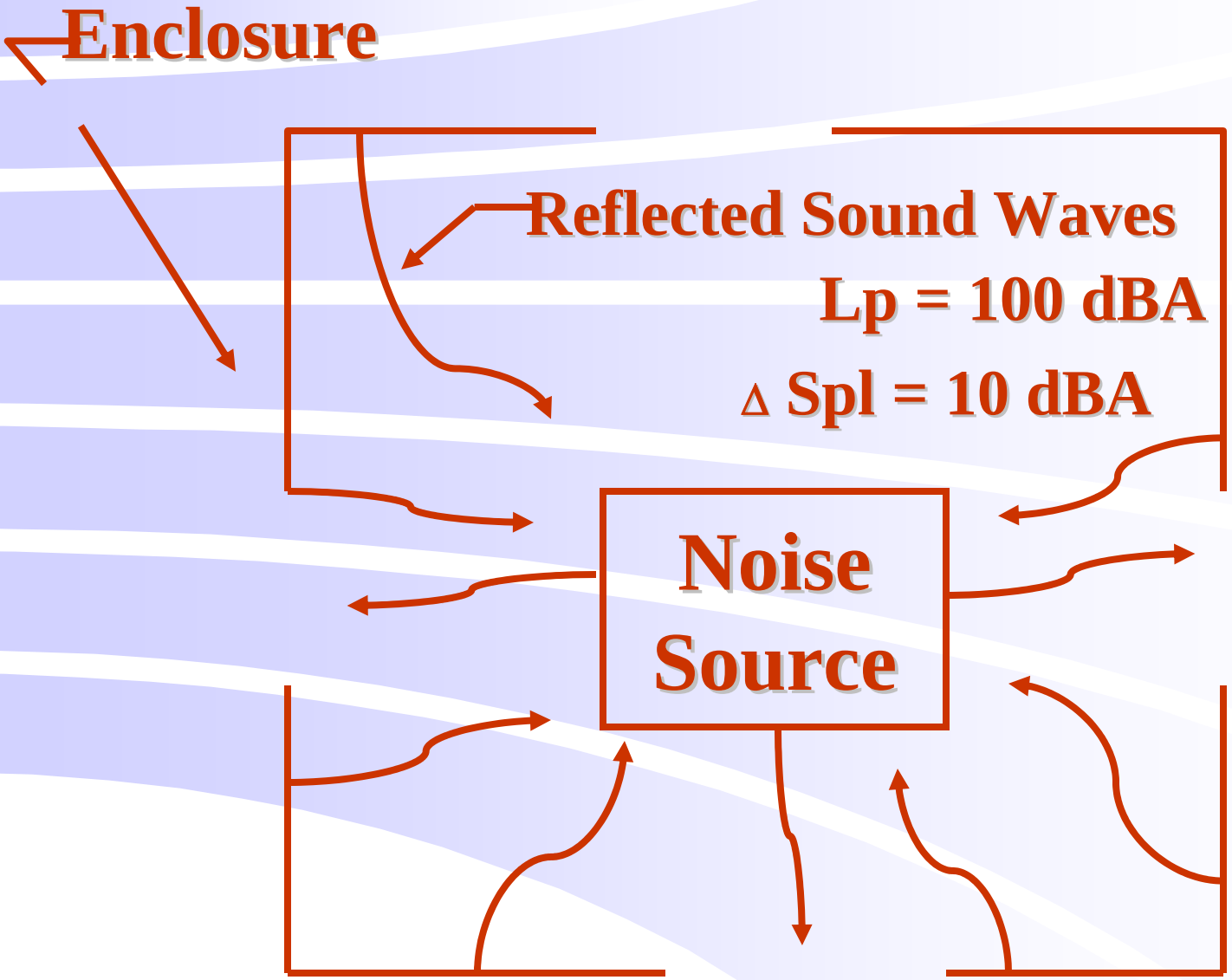
EFFECT OF INCIDENT SOUND ON A PARTITION




L_p = 90 dBA
NOISE SOURCE

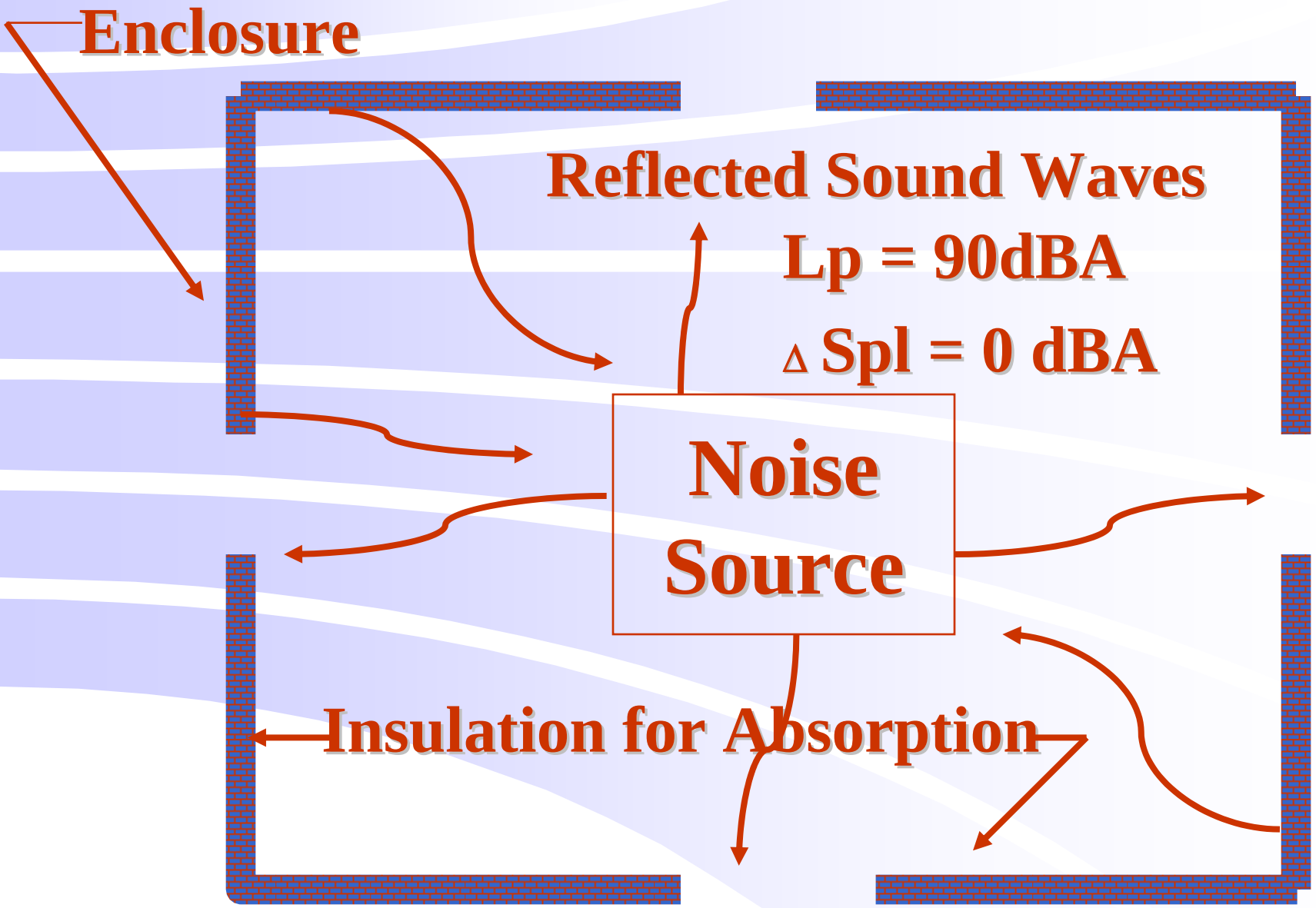

Enclosure
Reflected Sound Waves
Lp = 100 dBA
ΔSpl = 10 dBA
Noise Source
TL = 40 dBA
Spl = 60 dBA


Enclosure
Reflected Sound Waves
Lp = 90 dBA
ΔSpl = 0 dBA
Noise Source
Insulation for Absorption
TL = 40 dBA
Spl = 50 dBA



At 10% open area

TL = 10 dBA **Spl = 90 dBA**

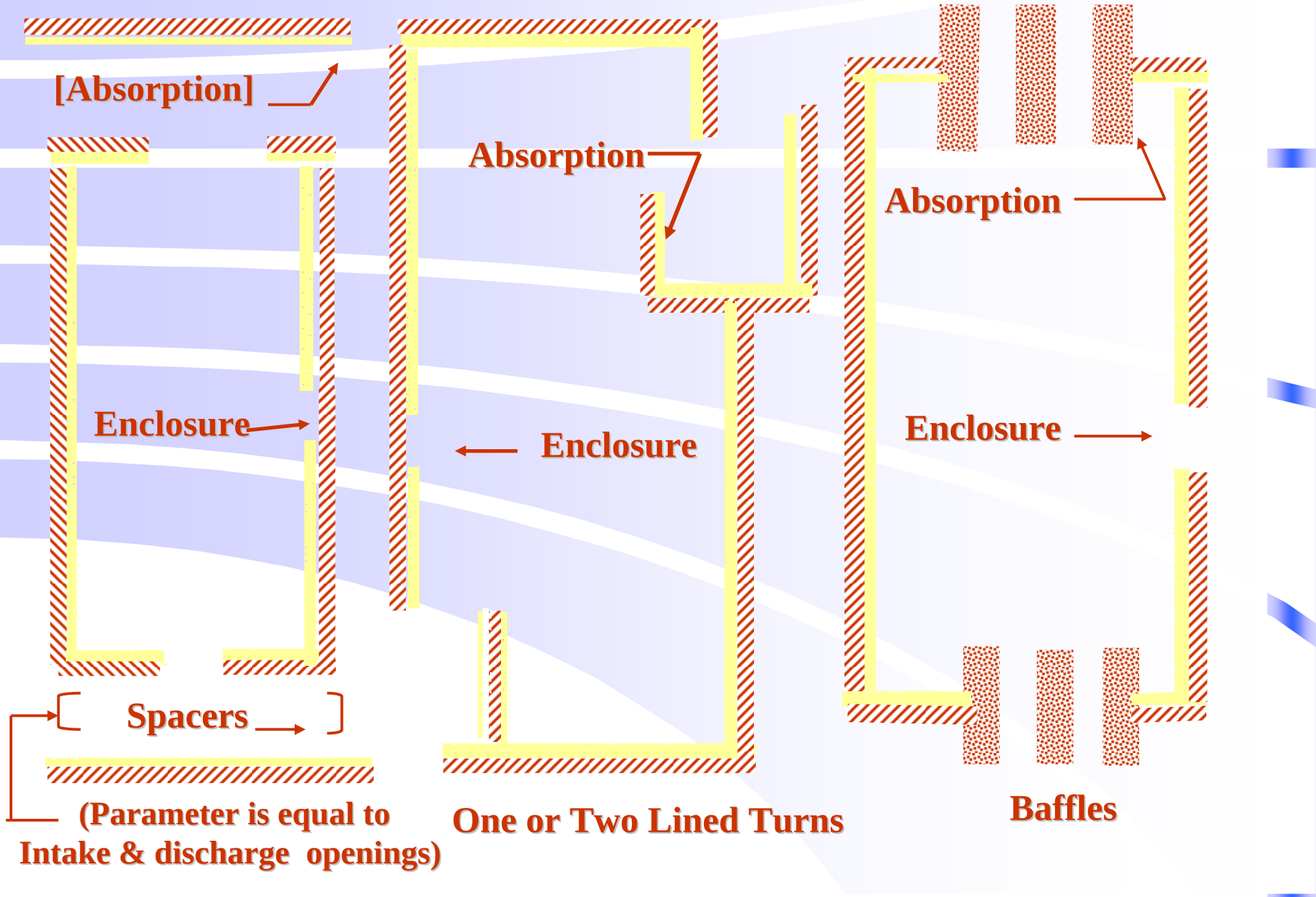


At 10% open Area

TL = 10 dBA

Spl = 80 dBA

Example of Typical Baffle Arrangements for Enclosures



Open Area Must Be Muffled Or Baffled

- ¼ Wavelength path of lowest frequency
- Baffle plate arrangement efficient
- Inline silencer requires attention regarding distance between baffle plates and insulation thickness.
- Typically the handling of open area is a major compromise.

ABSORBERS

SOUND ABSORBERS

Flexible and light weight, “Soak-up” airborne sound energy

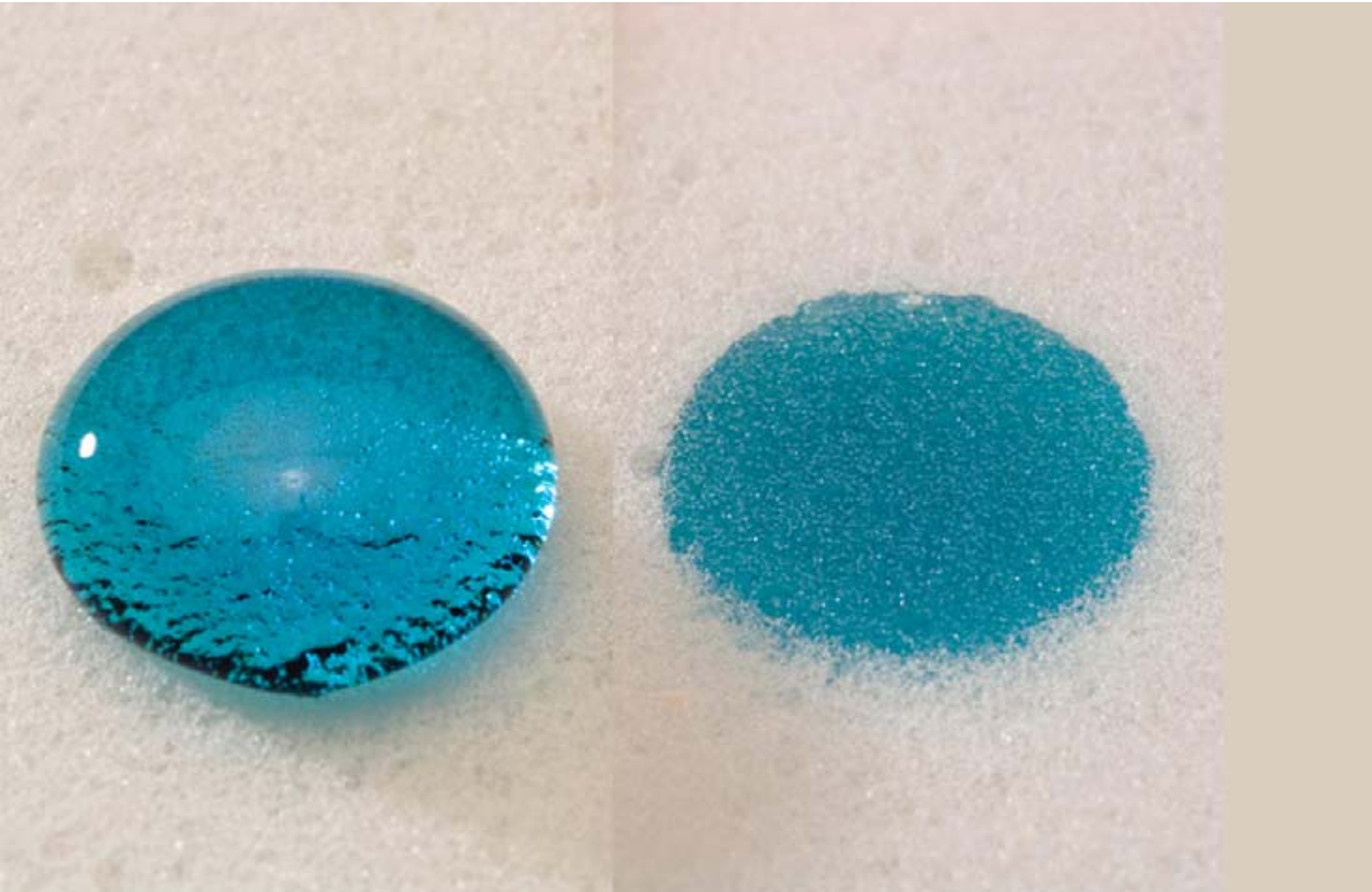
Cellular

- Urethane
  - High Smoke
  - Flammable
- Melamine
  - Low Smoke
  - Low Flame
- Polyimide
  - Low Smoke
  - Low Flame

Fiberous

- Fiber Glass
- Mineral Wool
- Ceramic
- Polyester
- Aramid

HYDROPHOBIC PHM vs STANDARD PMF



SOUND ABSORBERS FOR MINING APPLICATIONS

- CONSIDERATIONS:
  - LOW SMOKE
  - LOW TOXICITY
  - LOW FLAME
- MELAMINE FOAM IS IDEAL
  - MELAMINE COMPOSITES USED IN AEROSPACE APPLICATIONS

SURFACE TREATMENTS ON ABSORBERS

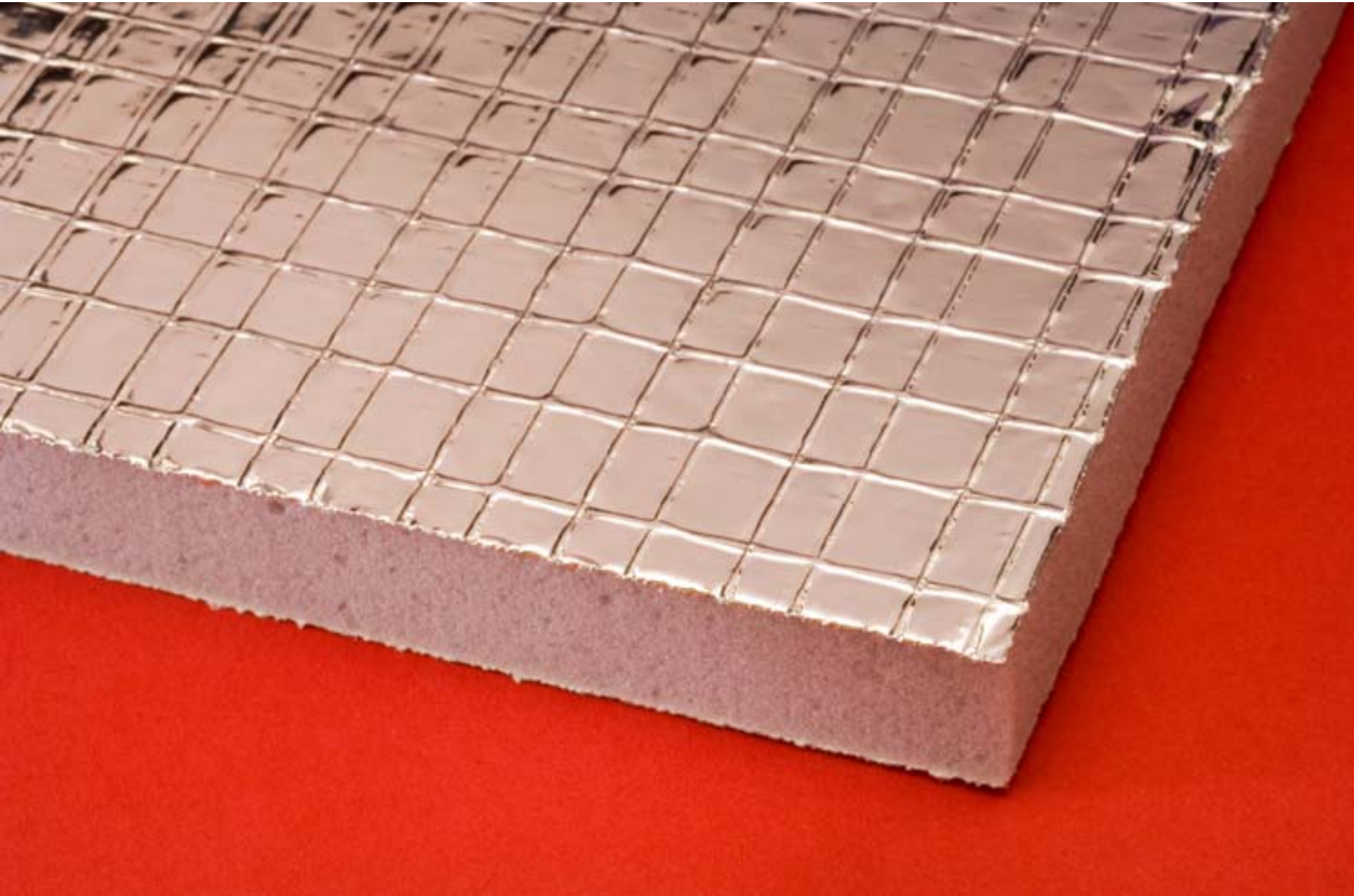
Film Facings

- Causes Resonance in Composite
- Helps Low Frequency Absorption
- Hurts High Frequency Absorption

Film Facings Protect Foam

- Keeps Out Contaminants
- Prolongs Product Life

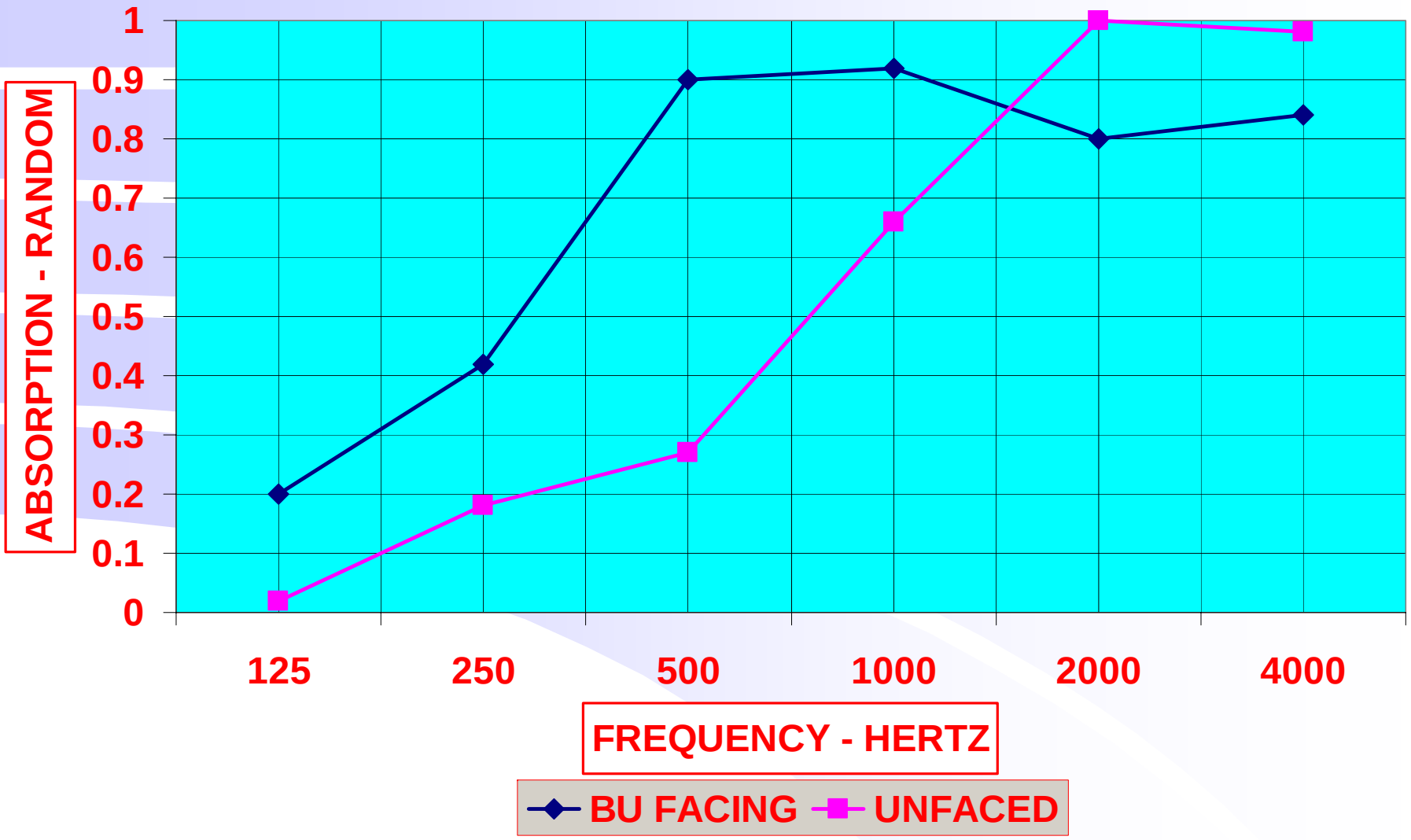
REINFORCED ALUMINUM FACING



PEKK or METALLIZED TEDLAR

KAPTON

EFFECT OF A FILM FACING - PAF100



WHERE ABSORBERS ARE USED:

- Full or partial enclosures
- Both thermal and acoustical benefits
- Noise reduction potential 2-8-dBA

Absorbers can be “enhanced” to fit requirements:

- Decorative/Protective surface treatments
- Fabricated to ease installation

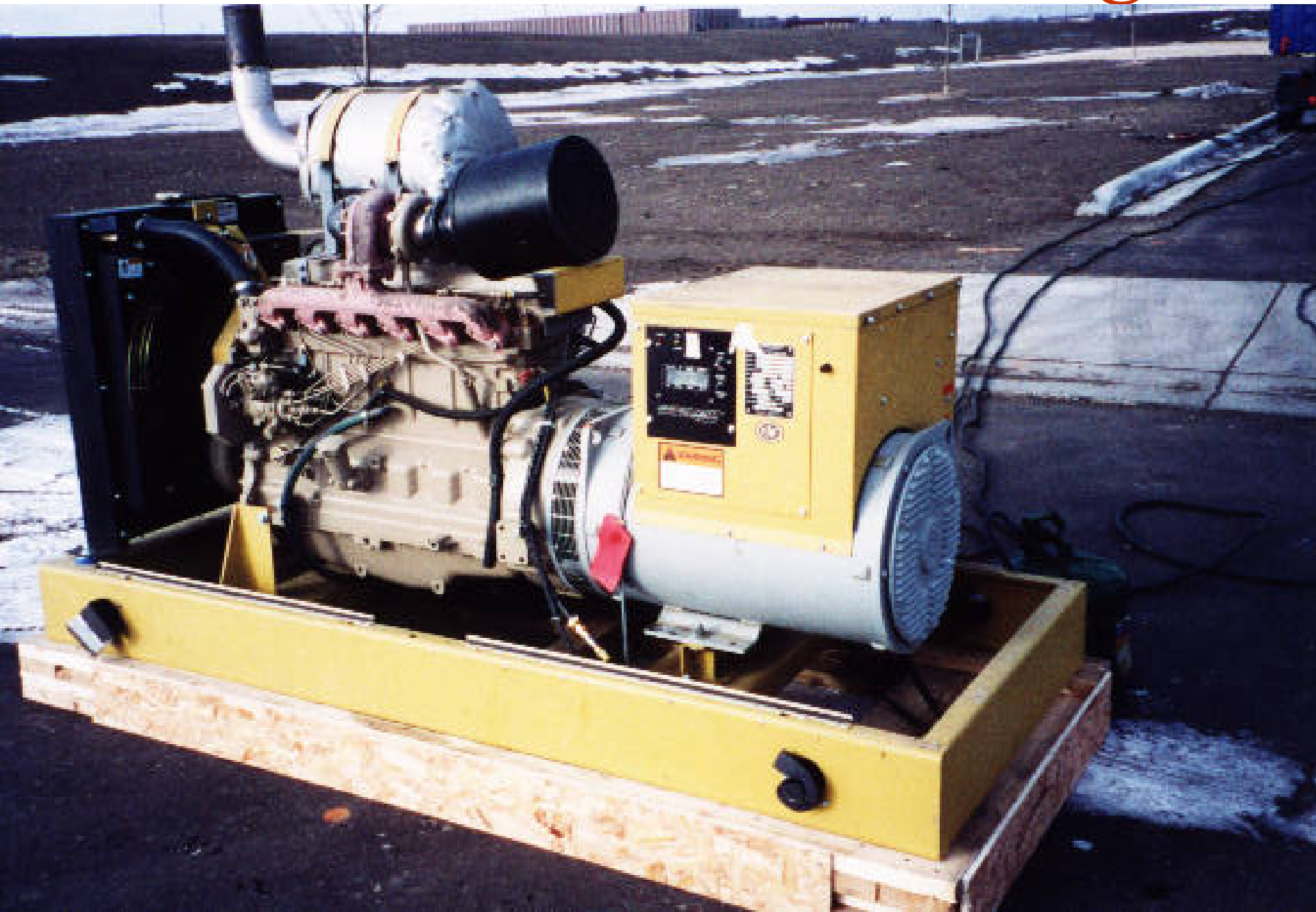
TYPICAL APPLICATIONS

- Under Engine Hoods
- Side Shields in Engine Compartments
- Under ROPS Cabs
- Inside Component Enclosures

CONSIDERATIONS

- COMPATABILITY WITH ENVIRONMENT
- DURABILITY
- EASE OF REPAIR, MODIFICATION and REPLACEMENT

125 KW GENERATOR – 87dBA@7M



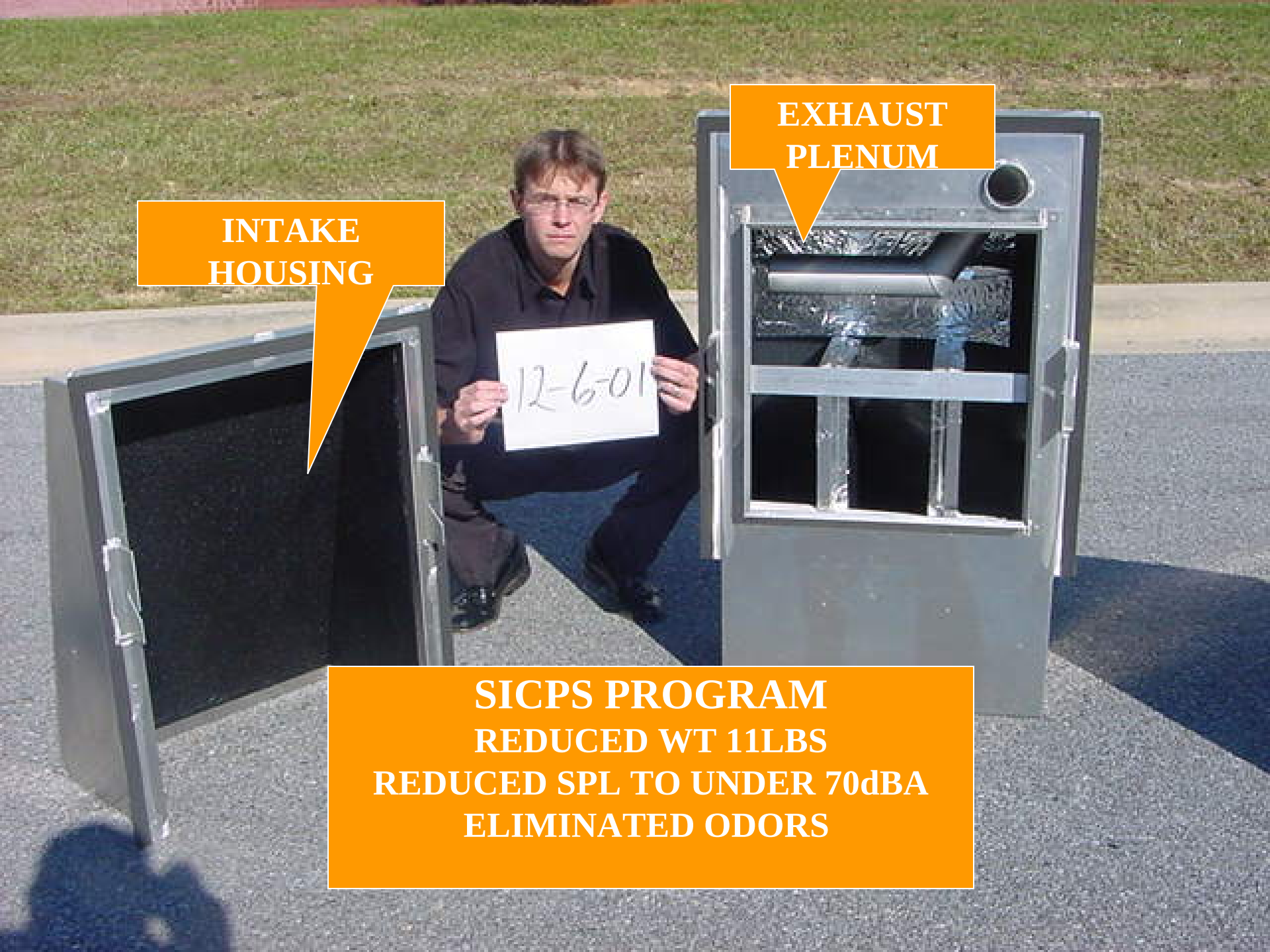
ENCLOSURE–NO INSULATION-83dBA - INSULATED – 80dBA

SILENCER W/O INSULATION–78dBA
WITH INSULATION-75dBA

VEHICLE ENGINE COMPT.-2dBA


MODEL V25ABC

CAB ENGINE TUNNEL



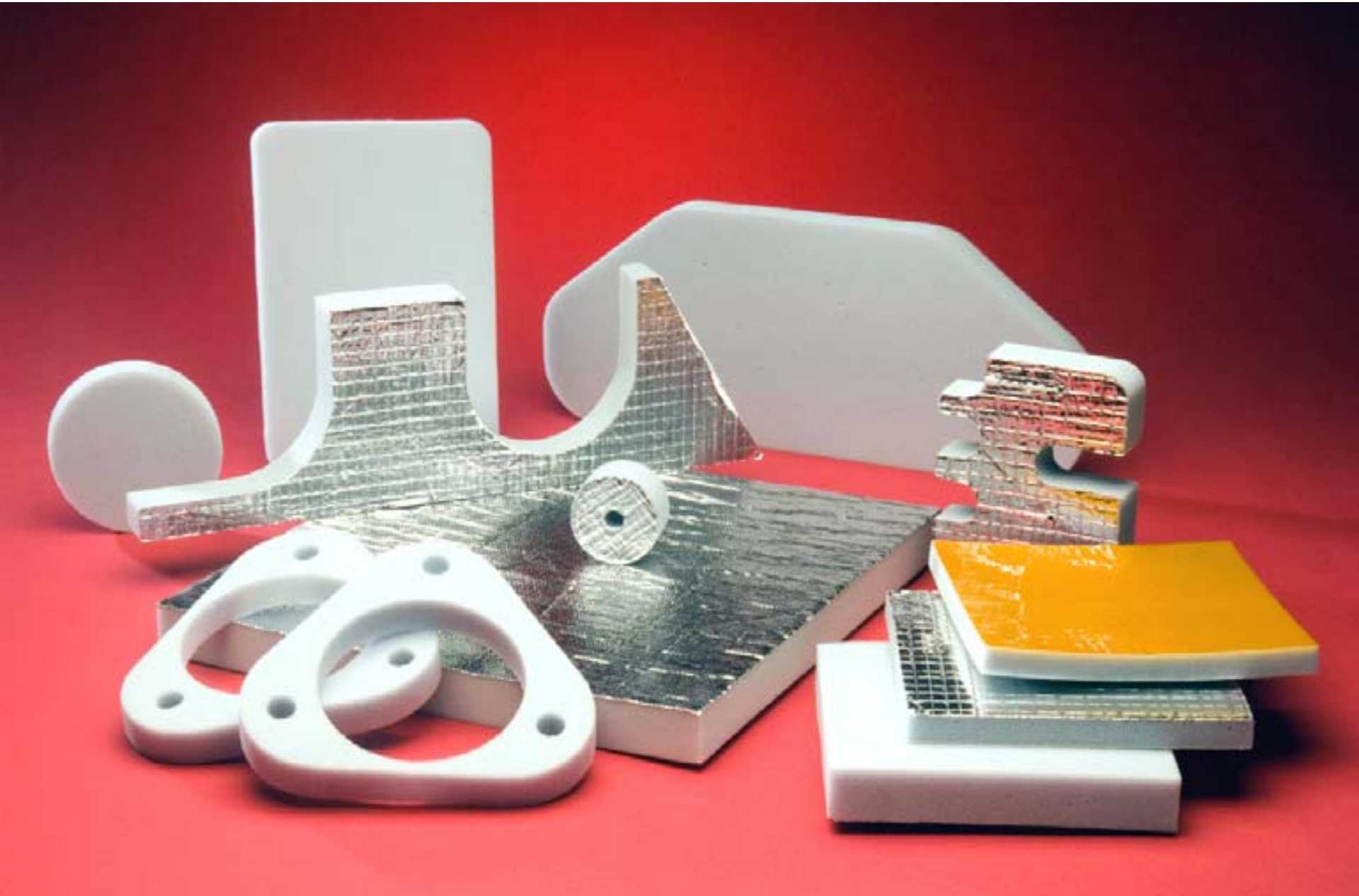
SICPS PROGRAM

REDUCED WT 11LBS

REDUCED SPL TO UNDER 70dBA

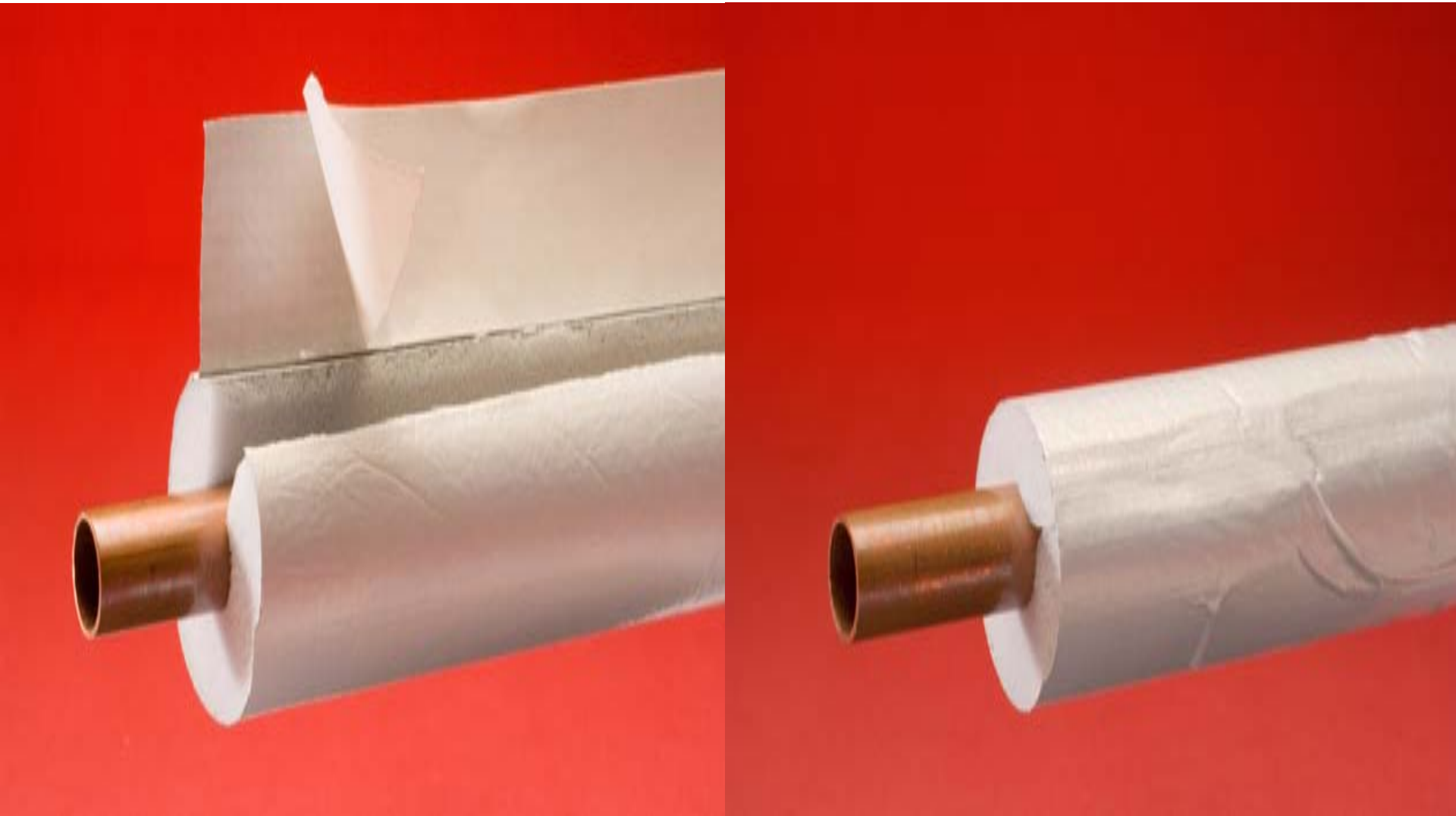
ELIMINATED ODORS

FABRICATED SHAPES

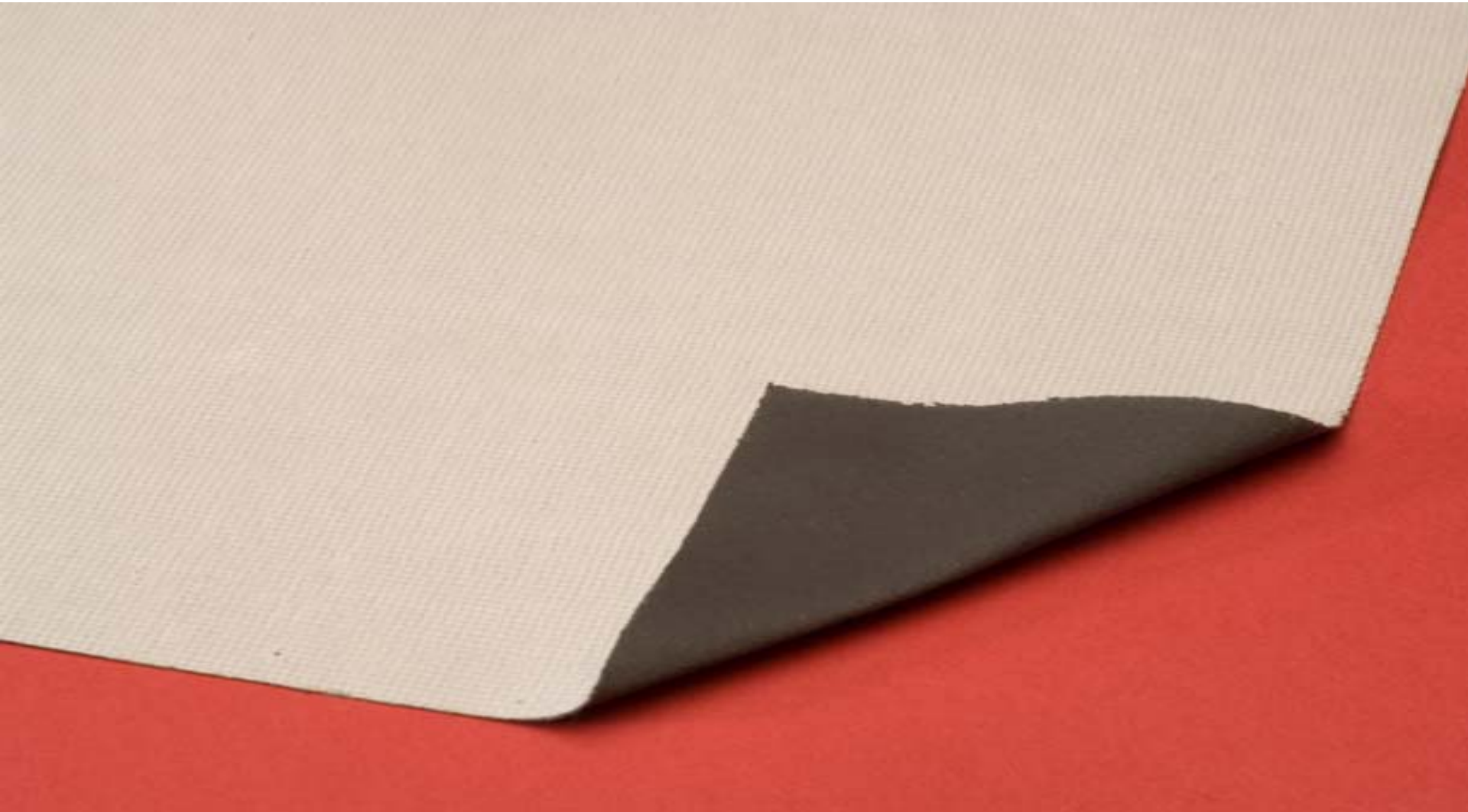


MILITARY HEADLINER

PIPE WRAP INSULATION



LIGHT WEIGHT AEROSPACE BARRIERS



CONSIDERATIONS FOR MINING APPLICATIONS

- **DURABILITY**
- **EXPANDED METAL PROTECTION**
  - **At least 22% open area – Acoustically Transparent.**
  - **Edges should be protected.**
  - **Hydrophobic Melamine should be used.**

BARRIERS

BARRIERS BLOCK NOISE

- Mass controls TL of panel
- Open area effects performance
- Composite absorber barriers are useful

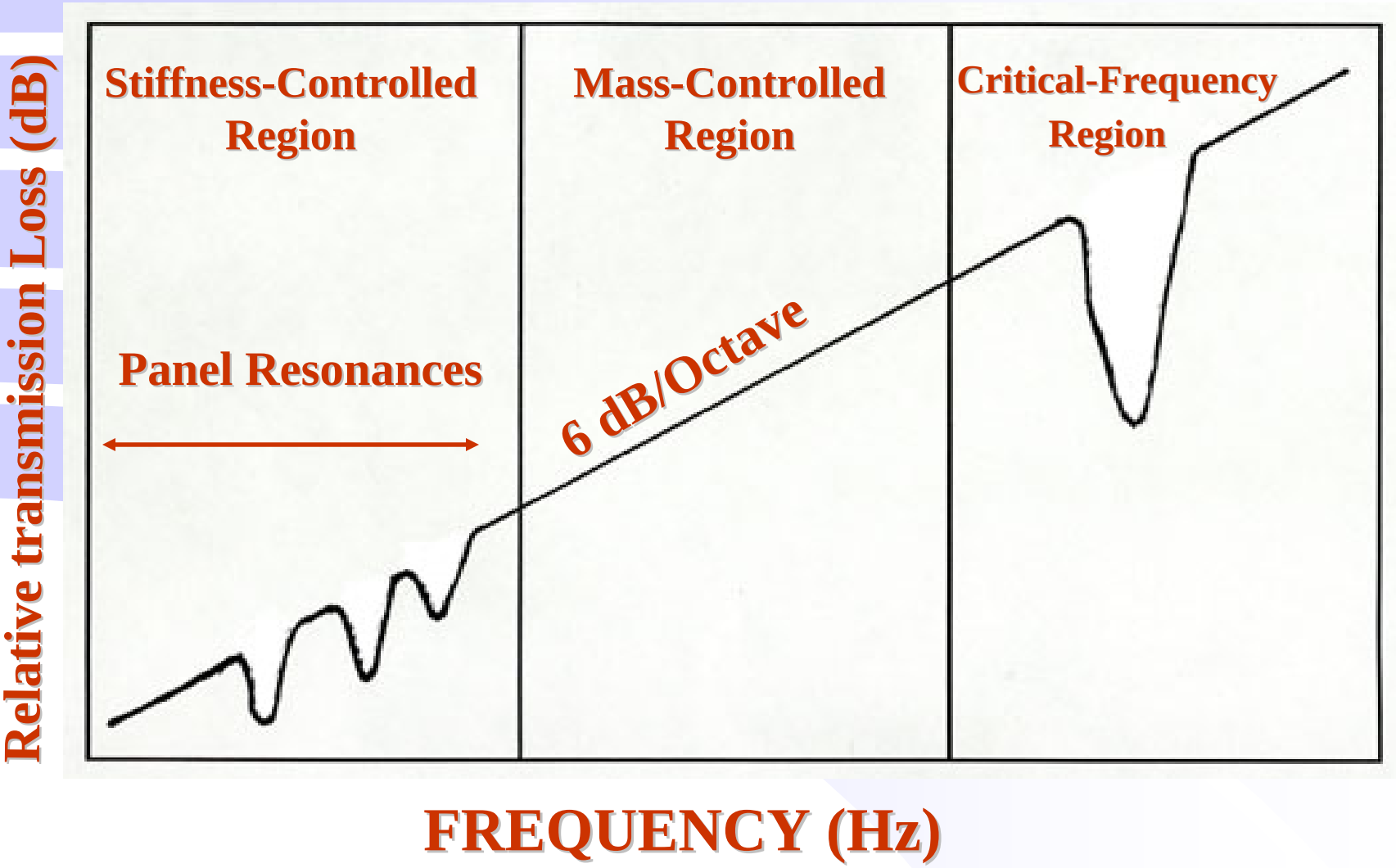
INVERSE SQUARE LAW

- Doubling distance from source decreases SPL by 6 db
- Halving distance from source increases SPL by 6 db

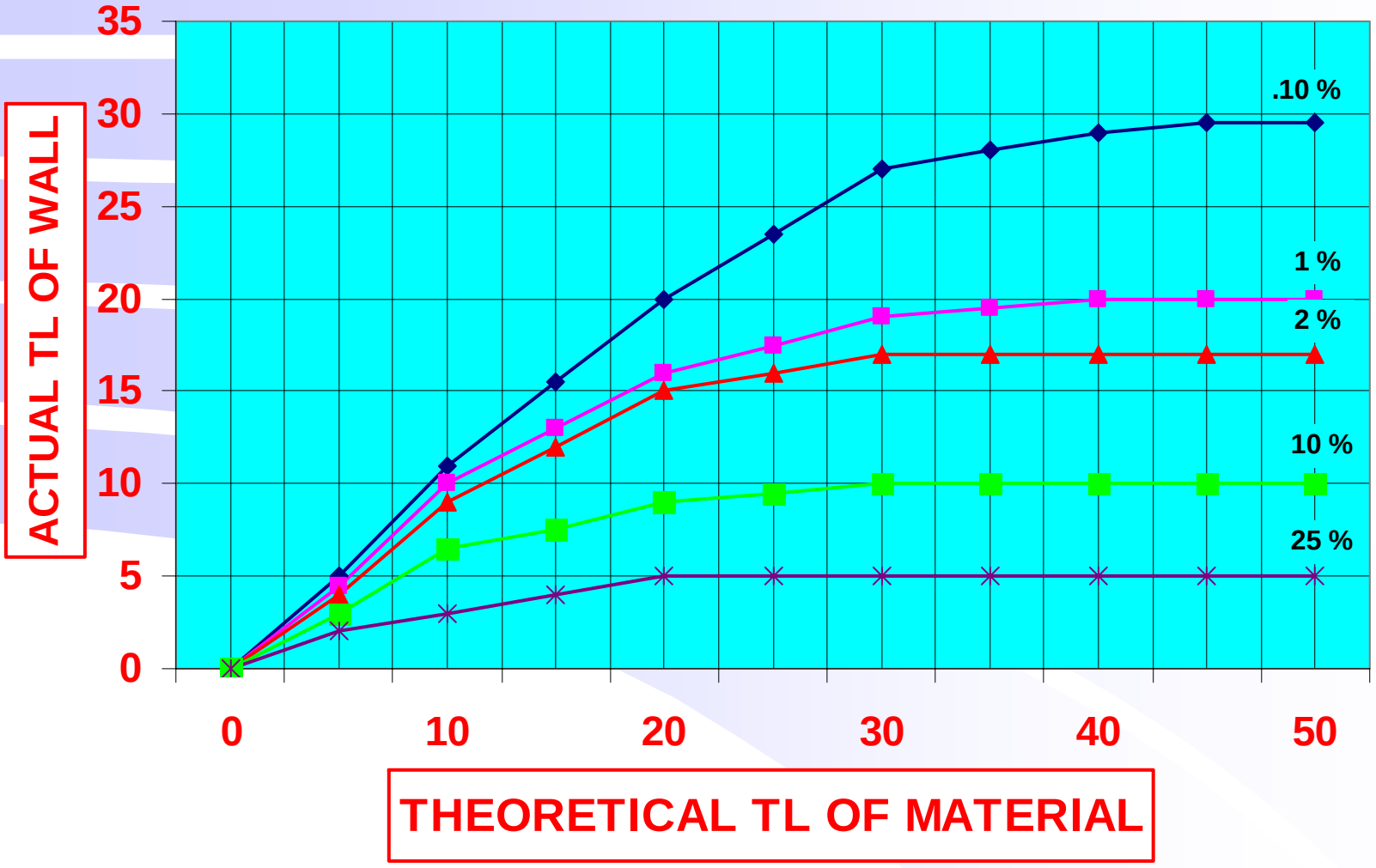
MASS LAW

- Doubling the mass of a barrier adds 6 db to the TL
- Halving the mass of a barrier decreases the TL by 6 db

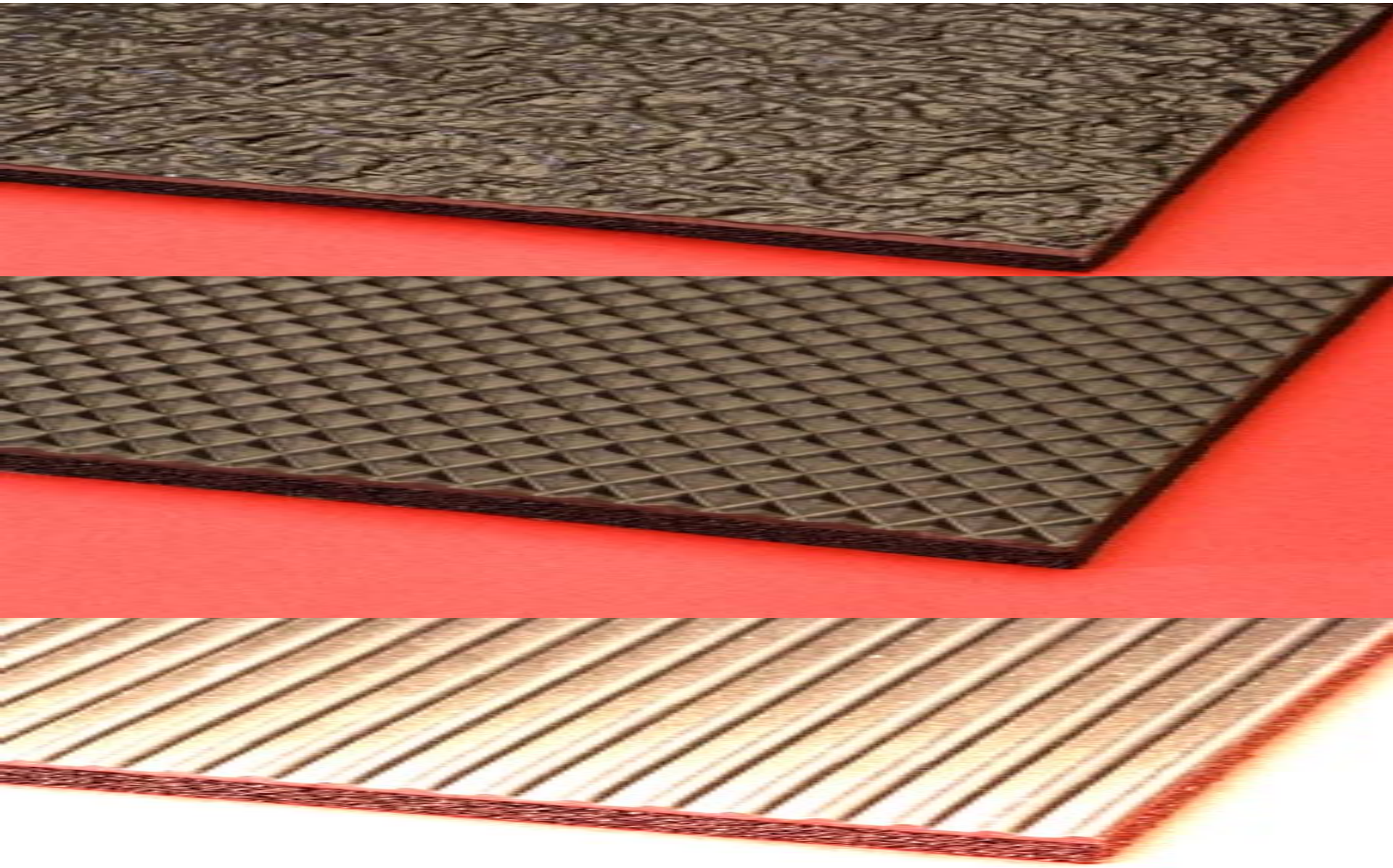
Typical Frequency Response (TL) of Homogenous Panels



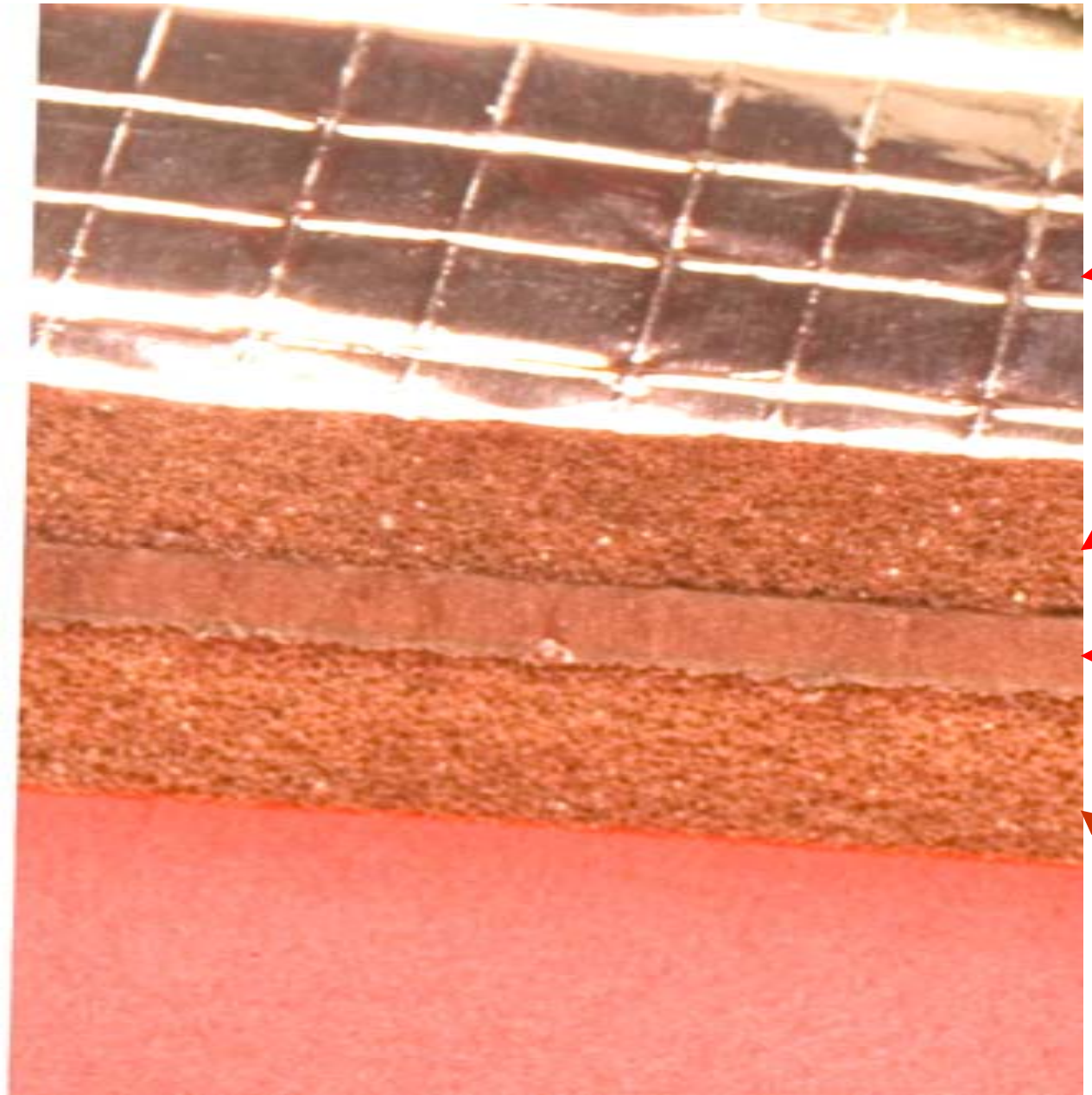
TRANSMISSION LOSS - ACT vs THEORETICAL



FLOORMATS



TYPICAL COMPOSITE BARRIER



FILM FACING

ABSORBER

BARRIER

DECOUPLER

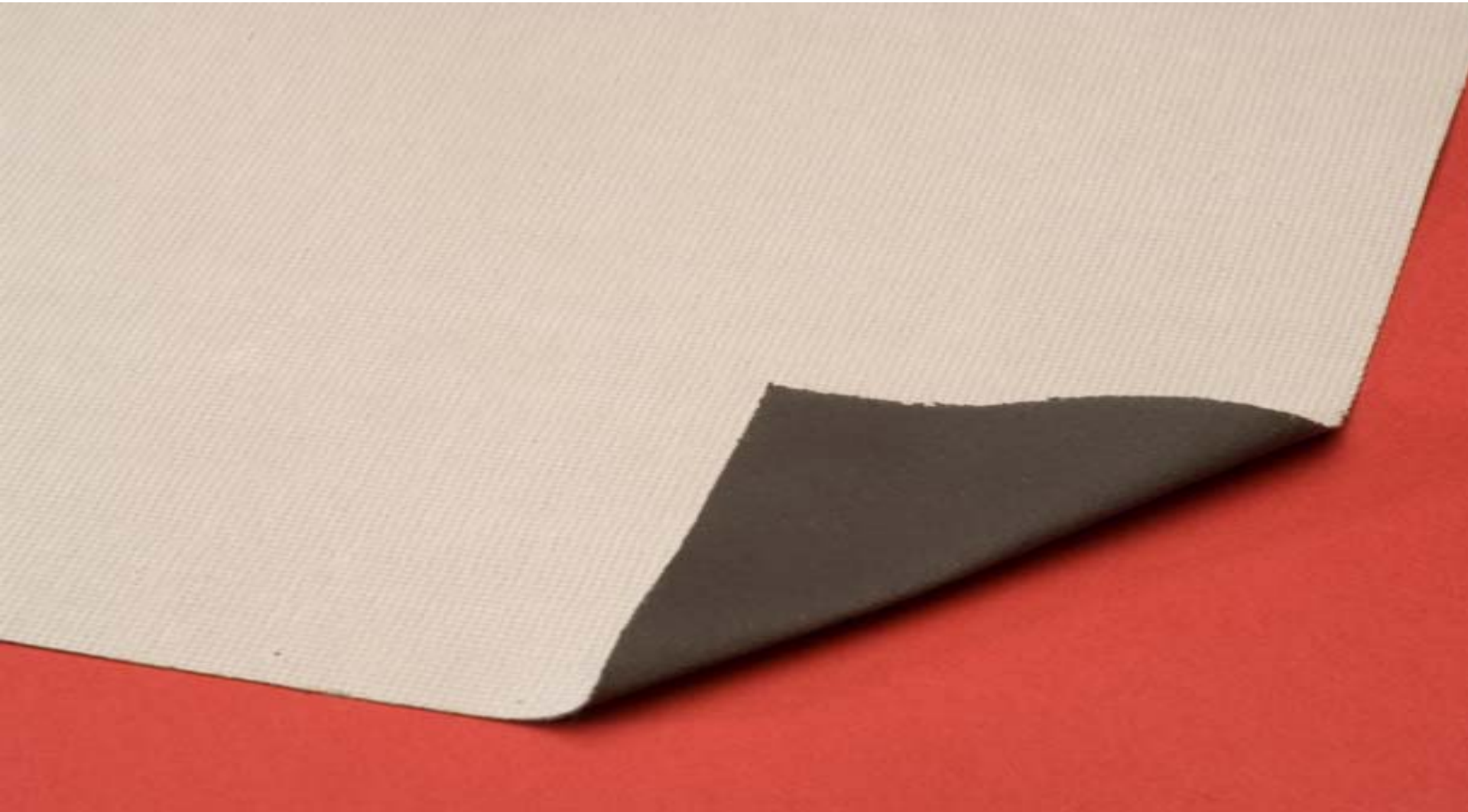
TYPICAL POLYMER BARRIERS

- CAN BE MADE SELF EXTINQUISHING
- HAVE SIGNIFICANT SMOKE ASSOCIATED WITH BURNING
- WILL NOT MEET STRINGENT TOXICITY REQUIREMENTS
- SUITED FOR ABOVE GROUND MINING VEHICLES
- OPTION – USE MELAMINE FOAM AS ABSORBER AND DECOUPLER

WHERE BARRIER COMPOSITES ARE USED

- VEHICLE FIREWALLS
- VEHICLE SIDE PANELS
- ENCLOSURES
- ANYWHERE ADDITIONAL TL IS DESIRED
- CAUTION – OPEN AREA IMPACTS VALUE OF BARRIERS

LIGHT WEIGHT AEROSPACE BARRIERS



BARRIER: - Walls to stop sound energy

- Existing structure vs. Supplemental
- Mass per unit area – Important
- Open area effects attenuation achieved

Noise Reduction Potential 10-40dBA

DAMPING

DAMPING

Eliminates Resonance

Stops Noise Radiation

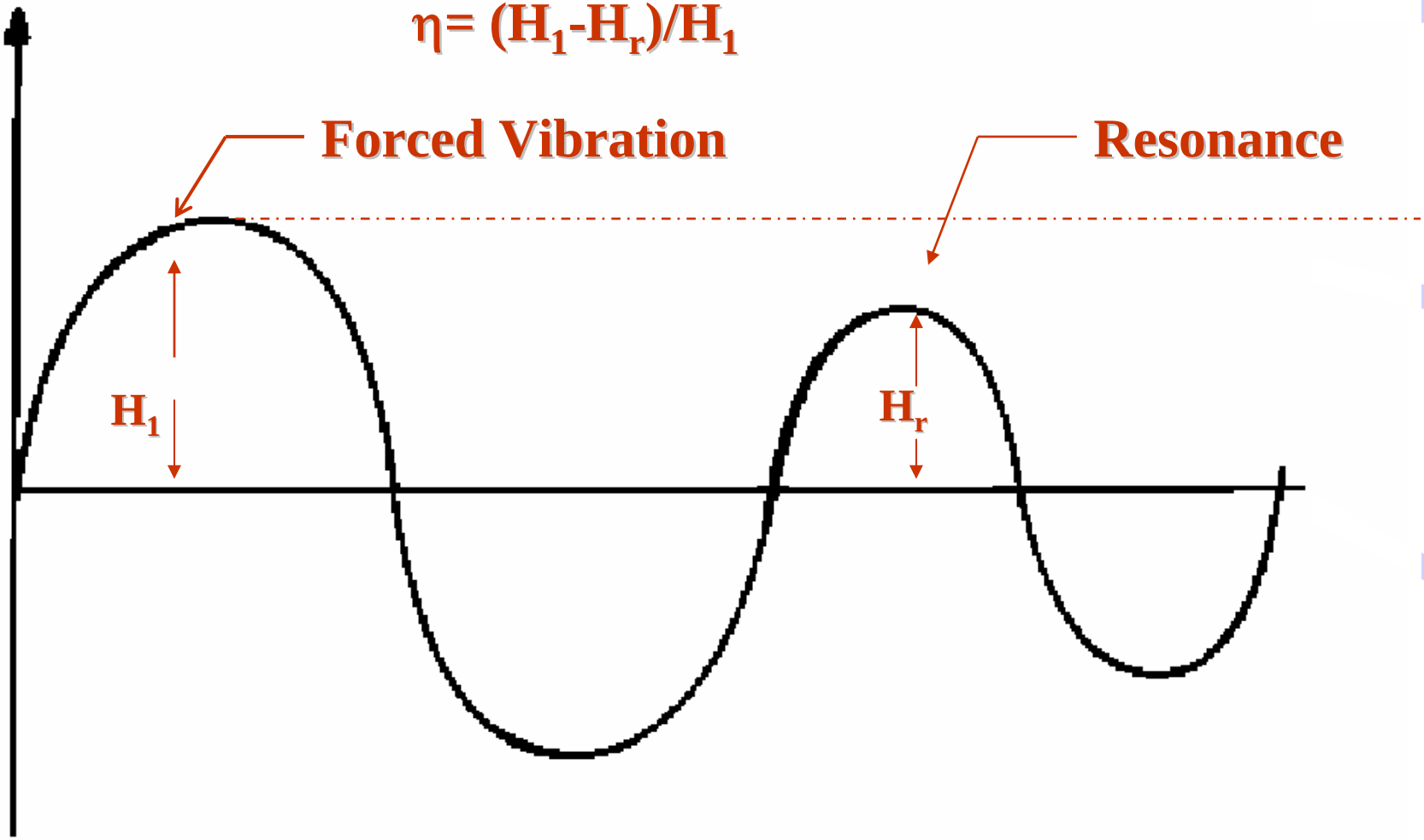
Allows TL to be Optimized

LOSS FACTOR

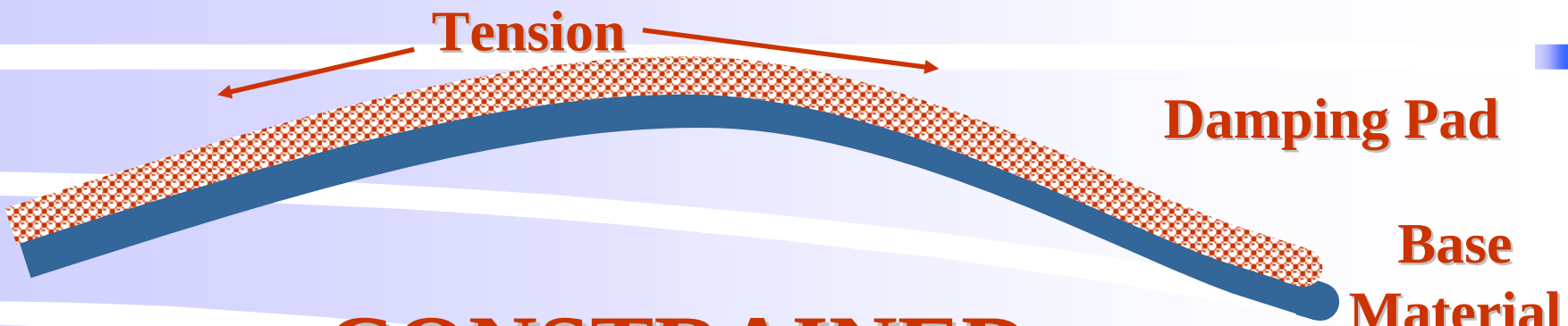
$$\eta_C = \frac{\text{Flexural Energy Lost per Cycle}}{\text{Flexural Energy Input per Cycle}}$$

Representation of Loss Factor

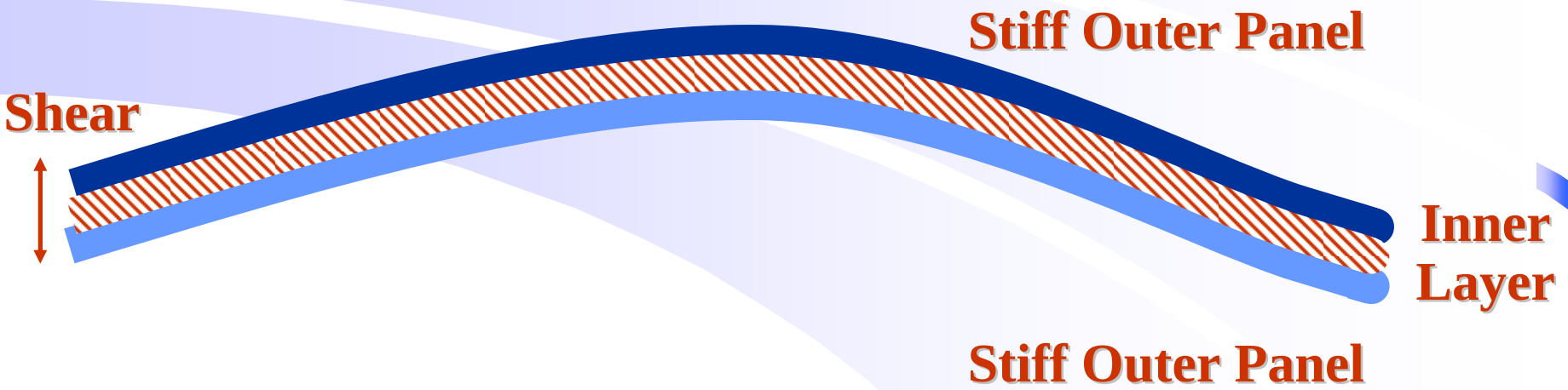
$$\eta = (H_1 - H_r)/H_1$$



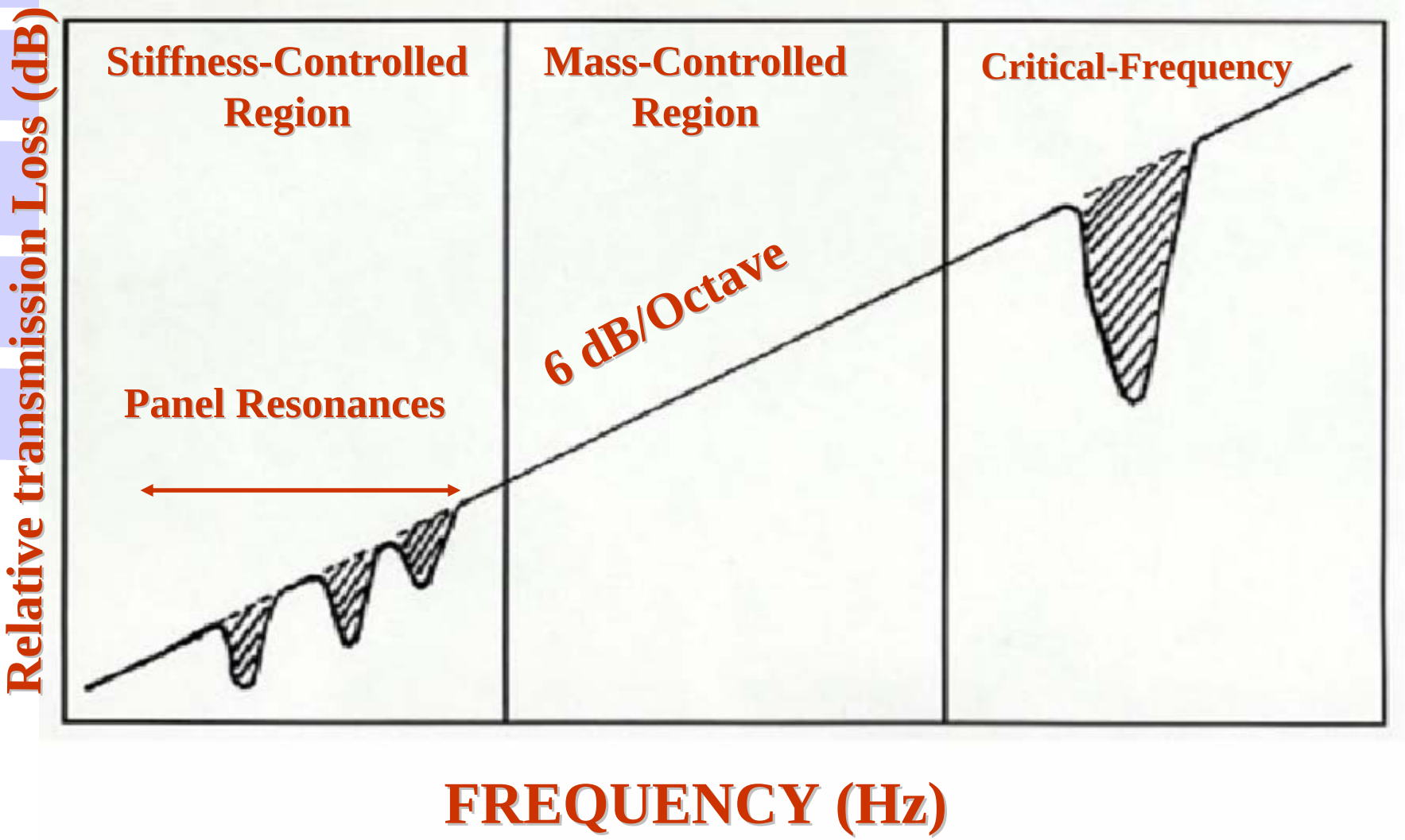
EXTENSIONAL

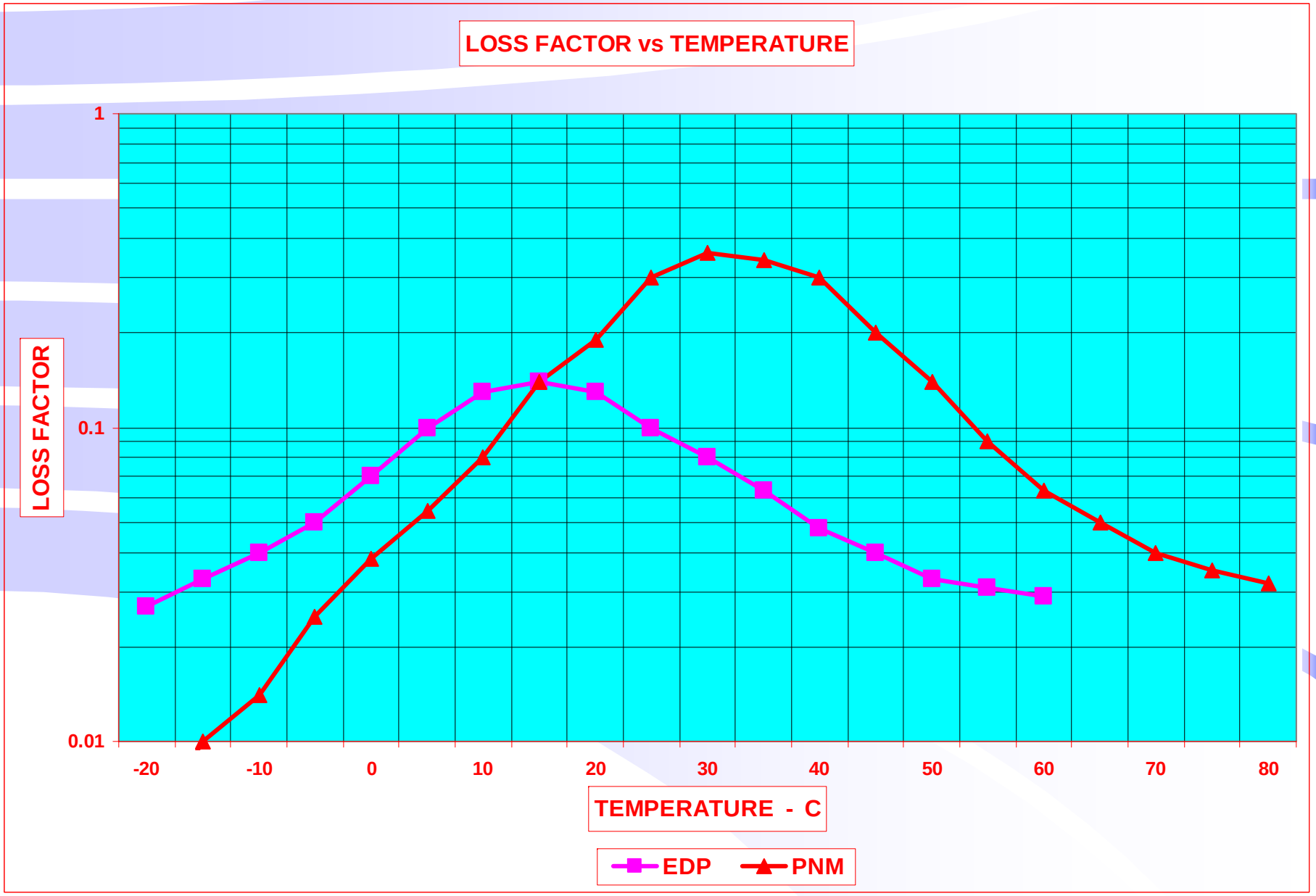


CONSTRAINED



TYPICAL FREQUENCY RESPONSE (TL) OF HOMOGENOUS PANELS




LOSS FACTOR vs TEMPERATURE
LOSS FACTOR
1
0.1
0.01
-20
-10
0
10
20
30
40
50
60
70
80
TEMPERATURE - C
EDP
PNM

CONSTRAINED LAYER DAMPING

- POLYMER TREATMENT IS PROTECTED
- CONSTRAINING LAYER OFFERS MAXIMUM DURABILITY
- HIGHEST POSSIBLE LOSS FACTORS
- IDEAL FOR MINING EQUIPMENT

DAMPING – Takes the “ring” out, Eliminates Resonance

- Reduces radiated noise
- Optimizes TL
- Materials are frequency & temperature sensitive
- Only reduces resonance – not forcing frequency

•Two Types

•Homogeneous (Free Layer)
- Apply at 1 to 1 ration
- Peel & stick, spray, trowel

•Constrained Layer
- Light Weight
- High Damping Performance
- Built in Design

Noise Reduction Potential 2-15 dBA

ISOLATION

- Properly “sized” to application
- Proper materials for application/environment
- Maximize efficiency for cost
- Noise Reduction Potential 2-20 dBA

GASKETING – Sealing Noise In or Out

- Designed for Use/Environment
- Requirements may narrow selection
- Price/Performance
- Low Compression Set

Noise Reduction Potential 2-10 dBA

Fastening Systems for Acoustical Materials

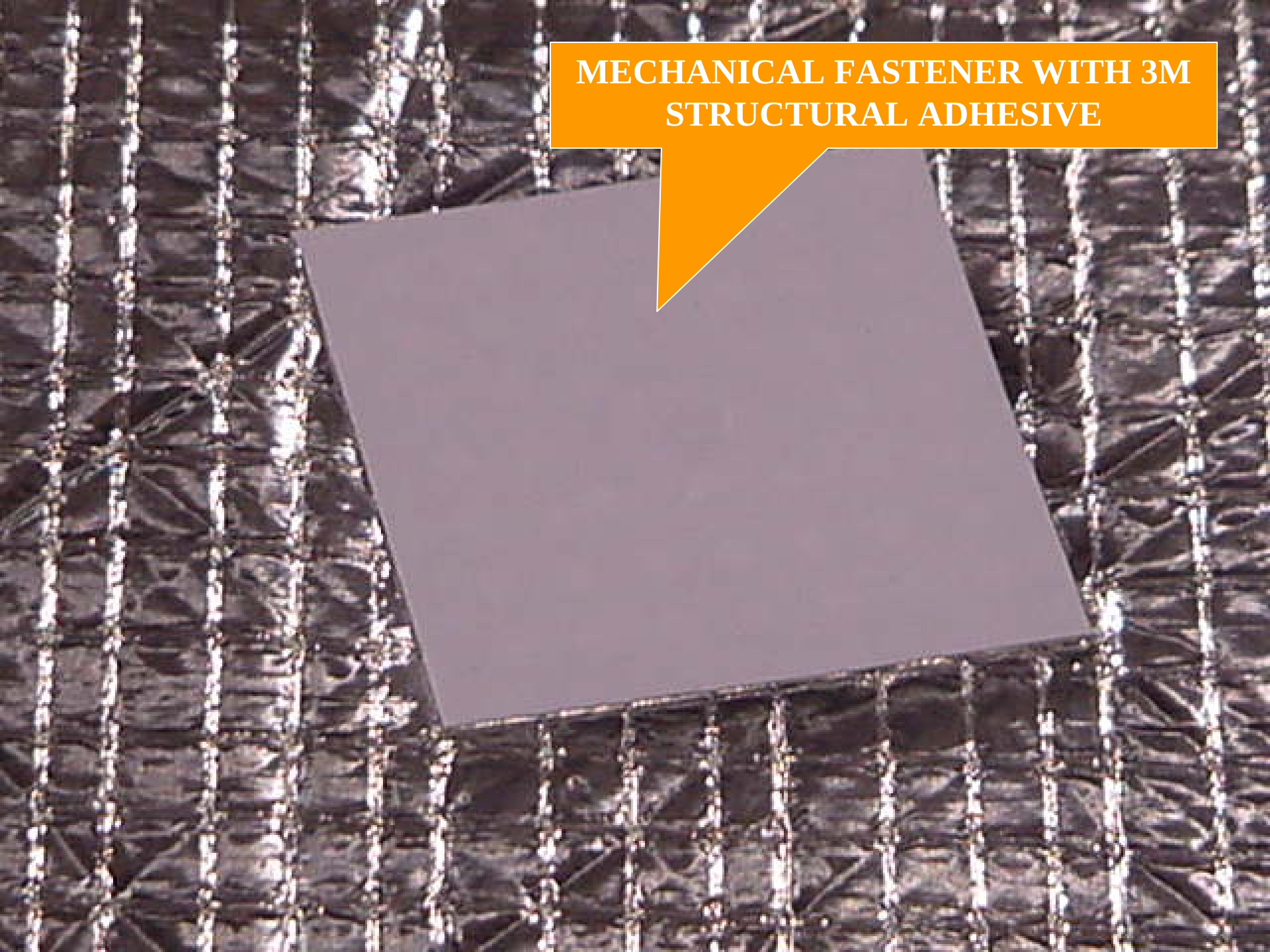
Adhesives - (Flammability may be an Issue)

Spray	Permanent, Potential Over-Spray, Cure Time
PSA	Fast, Permanent, Easy

Mechanical

Pins	Most Common
Clips	Side Panels, Headliners, Require Backing Board
Snaps	Require Mates/Alignment
Velcro	Require Mates/Alignment


MECHANICAL FASTENERS
WITH PROTECTIVE CAPS


MECHANICAL FASTENER WITH 3M STRUCTURAL ADHESIVE

NOISE CONTROL SUPPLIER SHOULD OFFER

- Reliable Customer Service
  - –References/Customer List
  - –What have they done recently
- Engineering Support
- Economical Prototypes
- Quality Production
- ISO 9002 Quality System Certified

SUMMARY

Polymer Technologies Supplies:

- A Full Range of Engineered Components.
- The Best Customer Service in Our Industry.

AND

- The Best Technical Support within Our Industry.

THANK YOU!